# State of CERES

Norman G. Loeb
NASA Langley Research Center, Hampton, VA


CERES Science Team Meeting, September 10, 2018
NCAR, Boulder, CO

# CERES Meeting

Review status of CERES Instruments and Data Products:

- Status of CERES
- CERES Terra, Aqua, S-NPP, NOAA-20 SW/LW/TOTAL Channel Calibration Update
- MODIS & VIIRS Cloud Algorithm & Validation Status
- ADM, SOFA, SARB and TISA Working Group Reports
- FLASHFLUX Update
- Data Management Team Update: Terra/Aqua/S-NPP

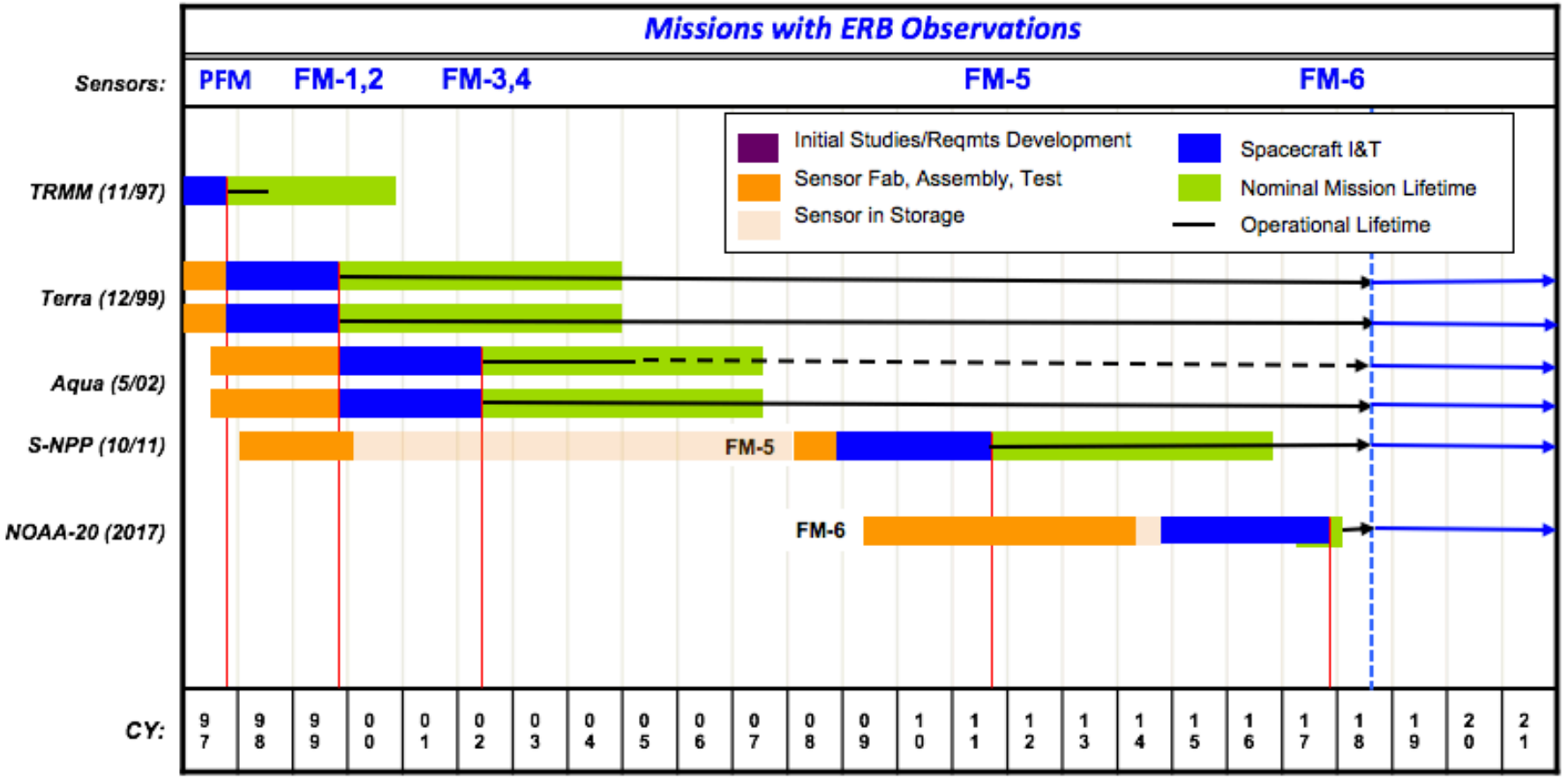
# Successful JPSS-1 Launch!

The Joint Polar Satellite System-1 lifted off from Vandenberg Air Force Base, California, on November 18, 2017 at 1:47 a.m. PST.

# RBI & Earth Venture Class Continuity

- Radiation budget instrument termination on January, 2018 due to cost overruns.
- NASA HQ developed a programmatic plan and associated schedule and budget that would enable an instrument capable of continuing the CERES radiation budget measurements.
- ERB Science Working Group of Civil Servants was formed to inform NASA on ERB observational requirements.
  - Final Report was completed September 7.
- New instrument will be competed under a new Earth Venture-Class Continuity announcement of opportunity.
- Data from this new instrument will be incorporated into the existing CERES ERB climate data record at LaRC.

# CERES Flight Schedules

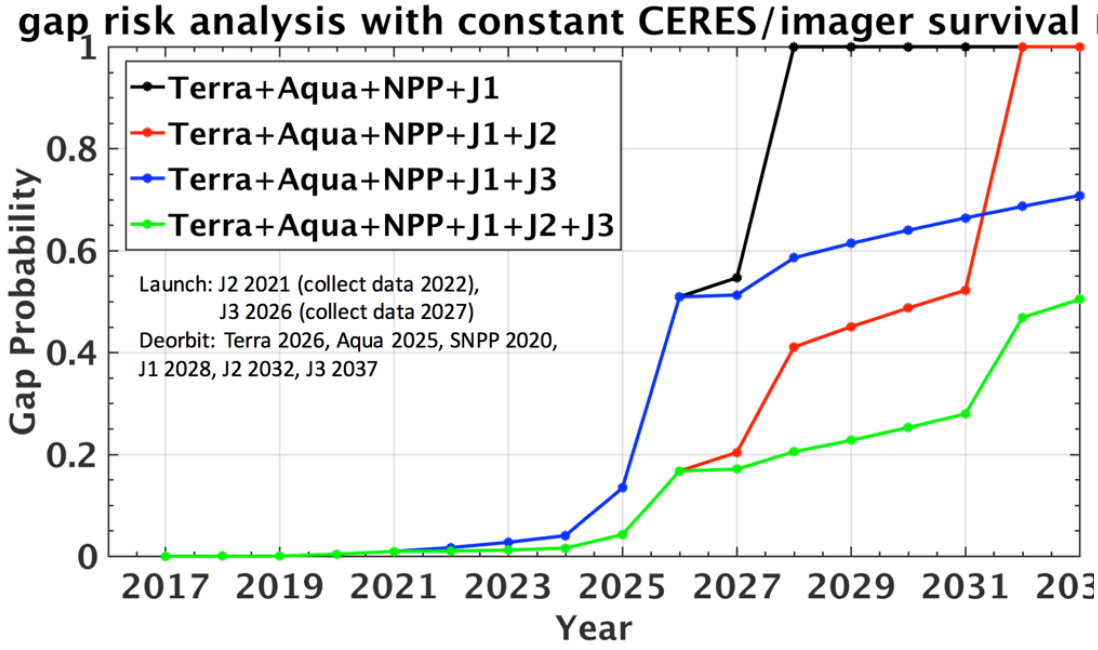



- Currently, 6 CERES instruments fly on 4 satellites: Terra (L1999), Aqua (L2002), SNPP(L2011), NOAA-20 (L2017)

# ERB Gap Risk Analysis

**Assumptions:**

- Constant CERES, imager & spacecraft survival rates.
- Fuel is the only limiting factor for Terra & Aqua de-orbit dates
- 8-year mission for S-NPP, 10-year missions for J1, J2, J3
- J2 launches in 2021 and J3 launches in 2026
- EVC ERB instrument can be accommodated on J3

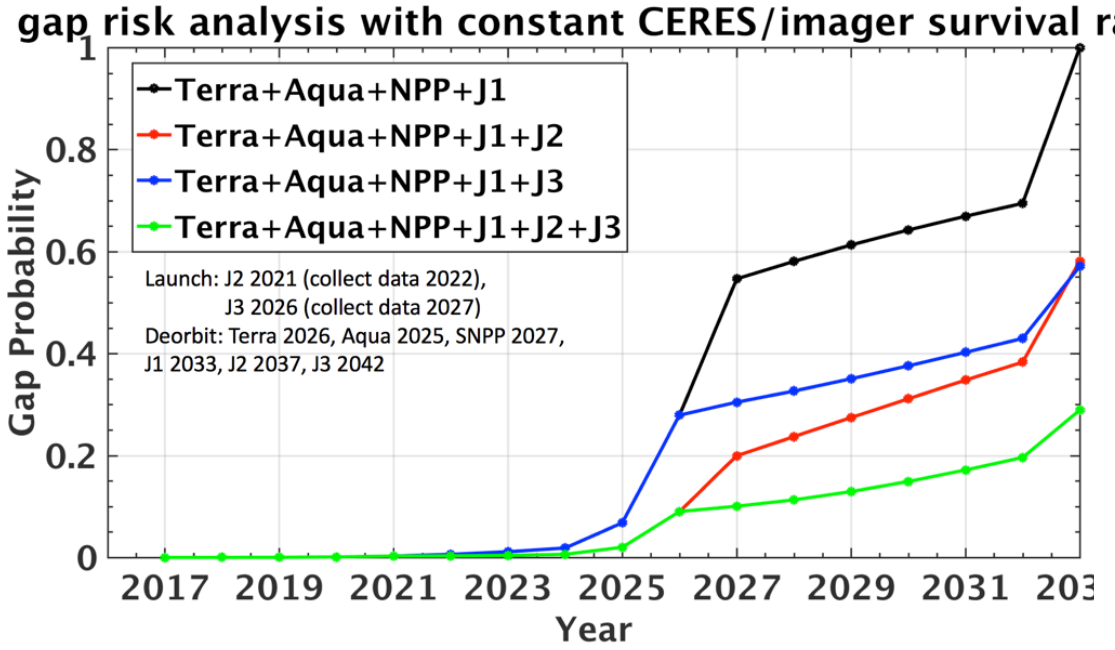



- The probability of a data gap in the ERB record reaches 51% in 2026 if no CERES follow-on launches before 2026.
- Had RBI flown on J2, the gap probability would have remained < 20% in 2026.

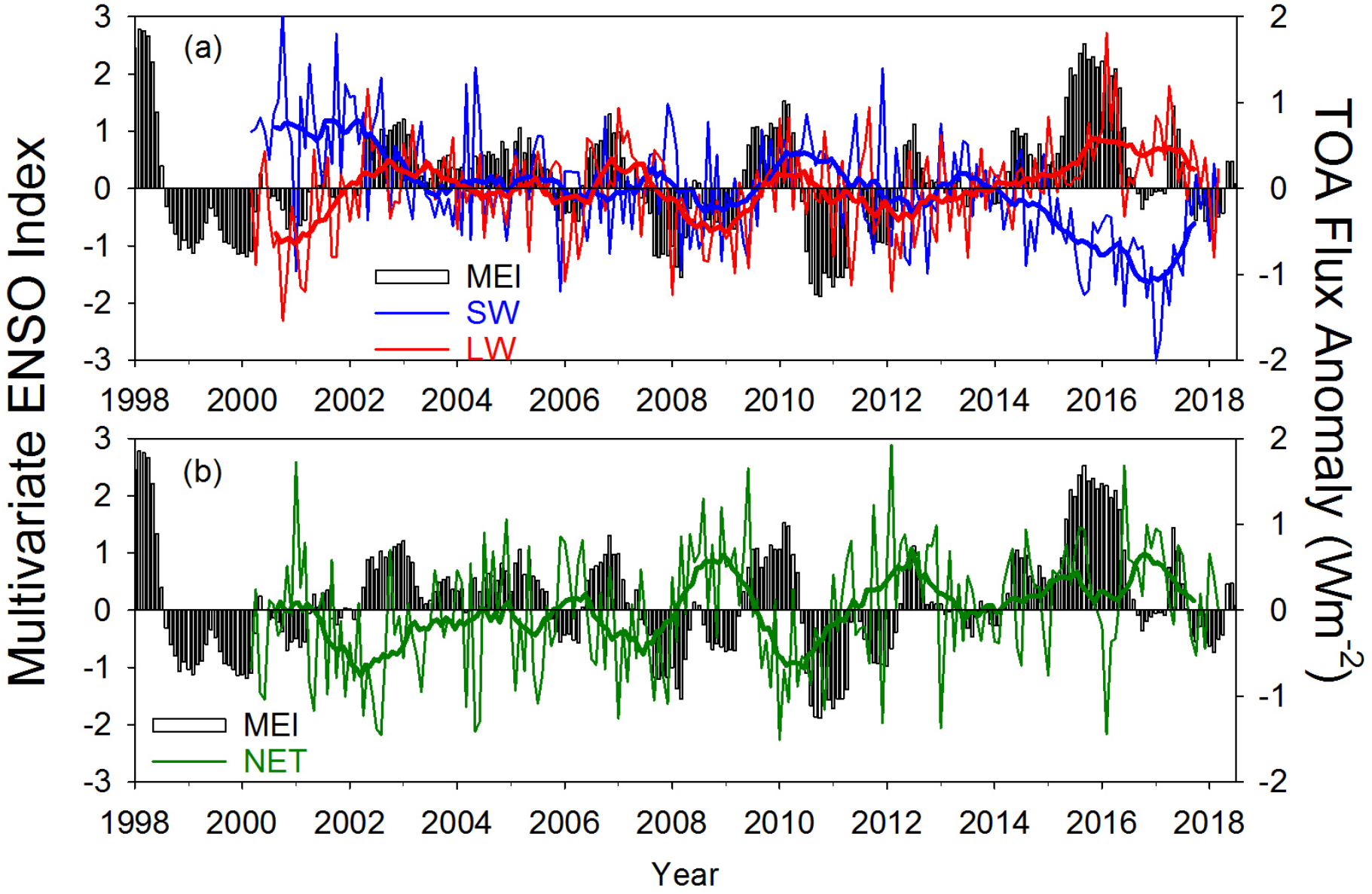
# ERB Gap Risk Analysis

**Assumptions:**

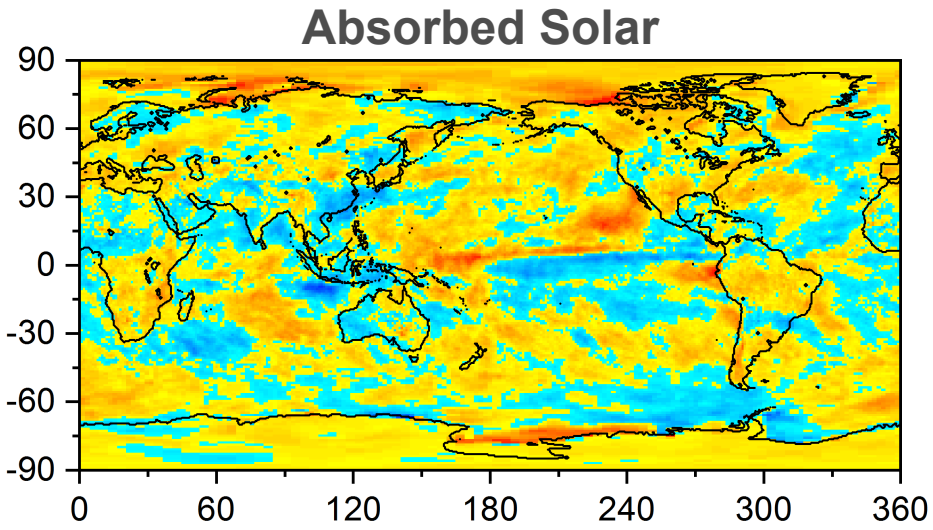
- Constant CERES, imager & spacecraft survival rates.
- Fuel is the only limiting factor for Terra & Aqua de-orbit dates
- 15-year mission for S-NPP, J1, J2, J3
- J2 launches in 2021 and J3 launches in 2026
- EVC ERB instrument can be accommodated on J3

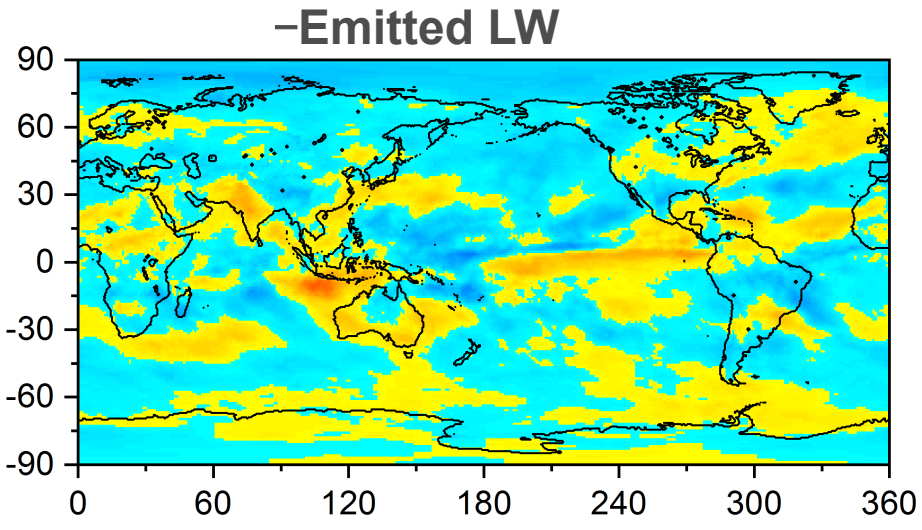


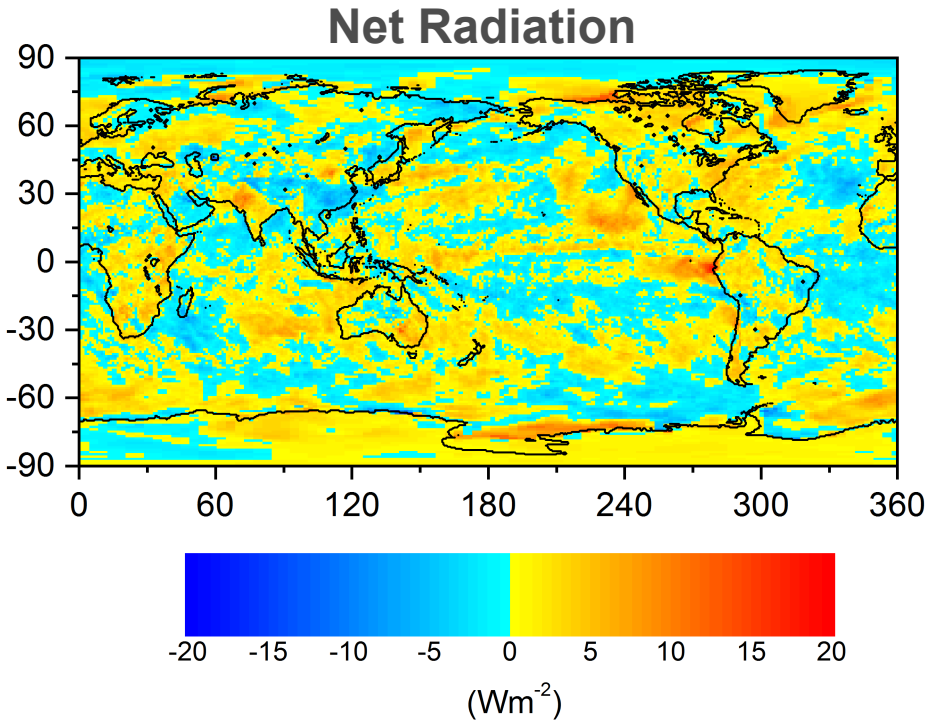

- The probability of a data gap in the ERB record reaches 51% in 2027 if no CERES follow-on launches before 2027.
- Launching a CERES Follow-on in 2026 reduces gap risk in 2027 to 30%.
- Had RBI flown on J2, the gap probability would have remained at ≈20% in 2027.

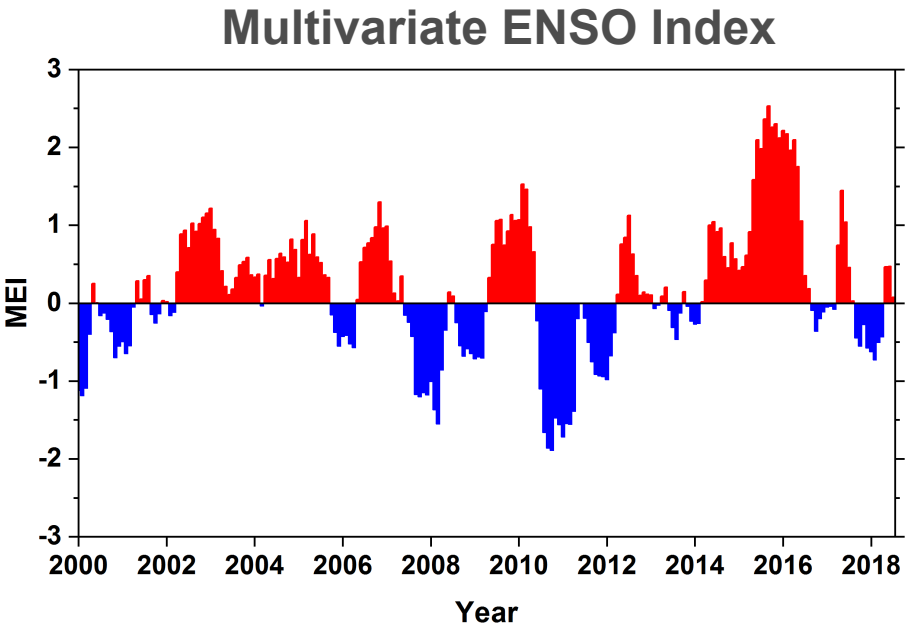

Global Mean All-Sky TOA Flux Anomalies & Multivariate ENSO Index
(CERES EBAF Ed4.0; 03/2000 – 03/2018)
(a)
MEI
SW
LW
(b)
MEI
NET
Multivariate ENSO Index
TOA Flux Anomaly (Wm-2)
Year
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
3
2
1
0
-1
-2
-3

# TOA Radiation Changes (March 2000 – March 2018)

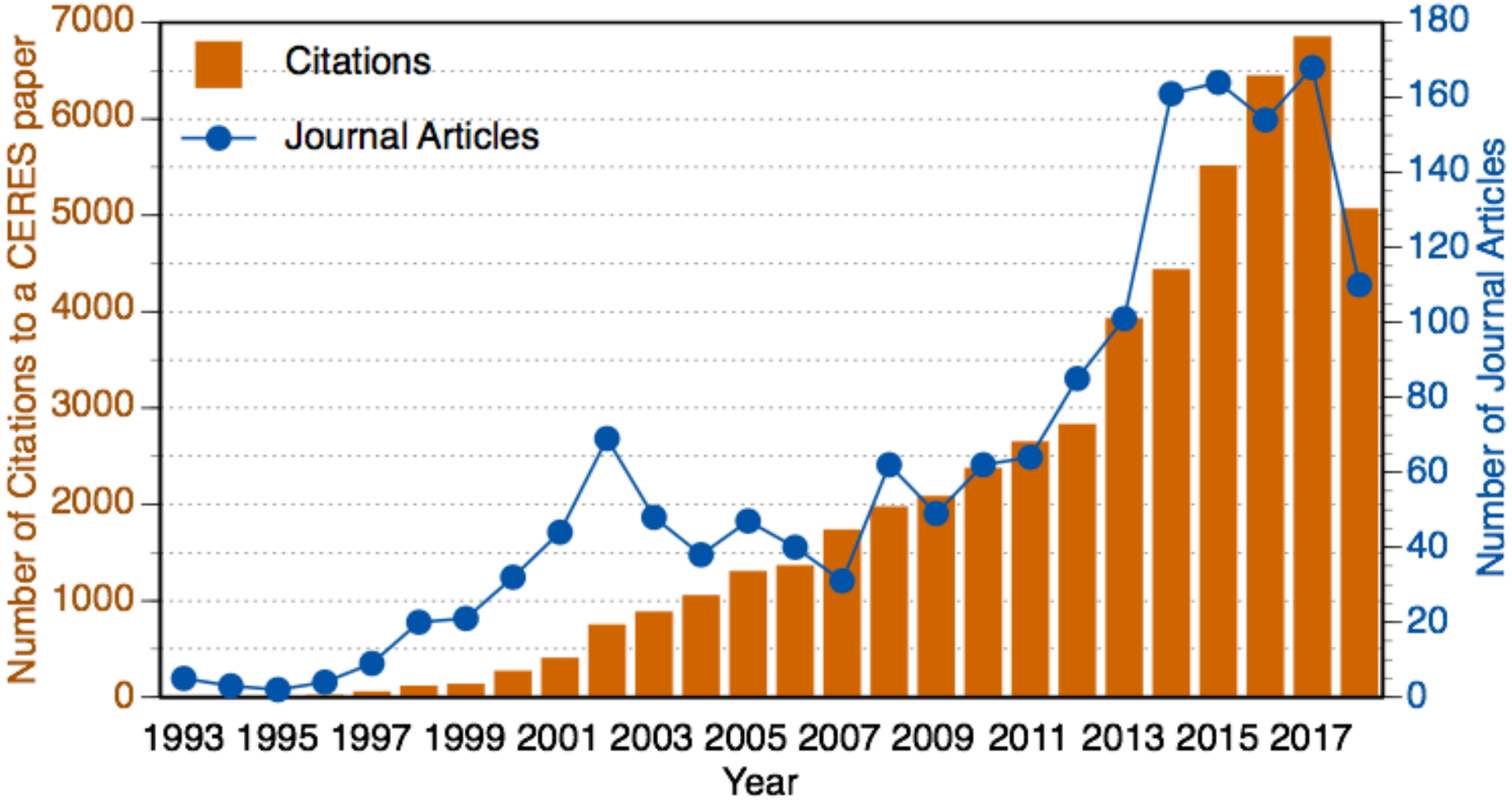


# CERES Journal Publications and Citation Counts
# (For Papers Between 1993-2018; Updated August 23, 2018)




- Total number of peer-reviewed journal articles: 1,593
- Total number of citations to CERES papers: 52,390

(Compiled by Anne Wilber & Dave Kratz)

# Number of Unique Users by CERES Data Product
## (through August 31, 2018)

| Level | Product | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1b | BDS | 11 | 9 | 14 | 19 | 14 | 11 | 13 | 14 | 7 |
| 2 | SSF | 84 | 77 | 138 | 223 | 247 | 253 | 278 | 327 | 174 |
| | FLASH_SSF | 25 | 8 | 15 | 23 | 30 | 61 | 41 | 68 | 75 |
| | C3M | 31 | 32 | 33 | 37 | 28 | 55 | 54 | 49 | 39 |
| | ES8 | 22 | 20 | 18 | 31 | 16 | 21 | 15 | 15 | 8 |
| | SSF-MISR | 9 | 4 | 2 | 5 | 4 | 2 | 1 | 3 | 1 |
| 3 & 3b | EBAF-TOA | 72 | 160 | 346 | 484 | 579 | 580 | 540 | 646 | 465 |
| | EBAF-Surface | | | 147 | 289 | 375 | 424 | 464 | 510 | 335 |
| | SYN1deg | 70 | 139 | 188 | 331 | 375 | 431 | 483 | 607 | 463 |
| | SSF1deg | 77 | 126 | 107 | 157 | 166 | 160 | 194 | 190 | 112 |
| | CldTypHist | 17 | 12 | 37 | 57 | 41 | 40 | 47 | 86 | 48 |
| | ES4 | 59 | 36 | 11 | 27 | 19 | 13 | 12 | 17 | 15 |
| | ES9 | 21 | 12 | 5 | 13 | 9 | 5 | 5 | 8 | 5 |
| | FLASH_TISA | 17 | 18 | 20 | 17 | 15 | 15 | 36 | 52 | 46 |

# CERES Terra and Aqua Data Product Availability

| Data Product | Level | Ed4.0 |
|---|---|---|
| BDS | 1 | 05/2018 |
| SSF | 2 | 05/2018 |
| SSF1deg | 3 | 04/2018 |
| SYN1deg | 3 | 03/2018 |
| CldTypHist | 3 | 01/2017 |
| EBAF-TOA | 3b | 03/2018 |
| EBAF-SFC | 3b | 03/2018 |

# Terra+Aqua Edition 4 Status

- The CERES Terra & Aqua Edition 4 processing uses MODIS radiances and aerosols as a key input.
- CERES Edition 4 started with MODIS Collection 5. However, C5 processing at GSFC was terminated at data date February 2017 and superseded with MODIS Collection 6.
- MODIS C6 has now been superseded by MODIS Collection 6.1.
- MODIS Collection 6.1 is a major calibration upgrade for select Terra (6.72 and 8.6 μm) and Aqua (visible) channels.
  - Will significantly improve the quality of the MODIS Terra water vapor channel (6.72 μm), which is used in the CERES cloud mask.
  - Entire MODIS C6.1 record is available.
- CERES Team will reprocess with MODIS C6.1 starting in March 2016, when the MODIS Terra water vapor channel showed a large spurious loss of sensitivity.
  - To mark the change, Edition 4.0 will be renamed to Edition 4.1.
  - CERES data through February 2016 will not be reprocessed until Edition 5.

# Planning for Terra+Aqua Edition 5

The following items need to be taken into consideration:

1) GMAO improvements to their atmospheric reanalysis system.

   - CERES and GMAO hold WebEx meetings every 3 weeks to gauge progress and provide ongoing validation results for the latest GEOS FP or FPIT version.

2) MODIS Collection 7 schedule.

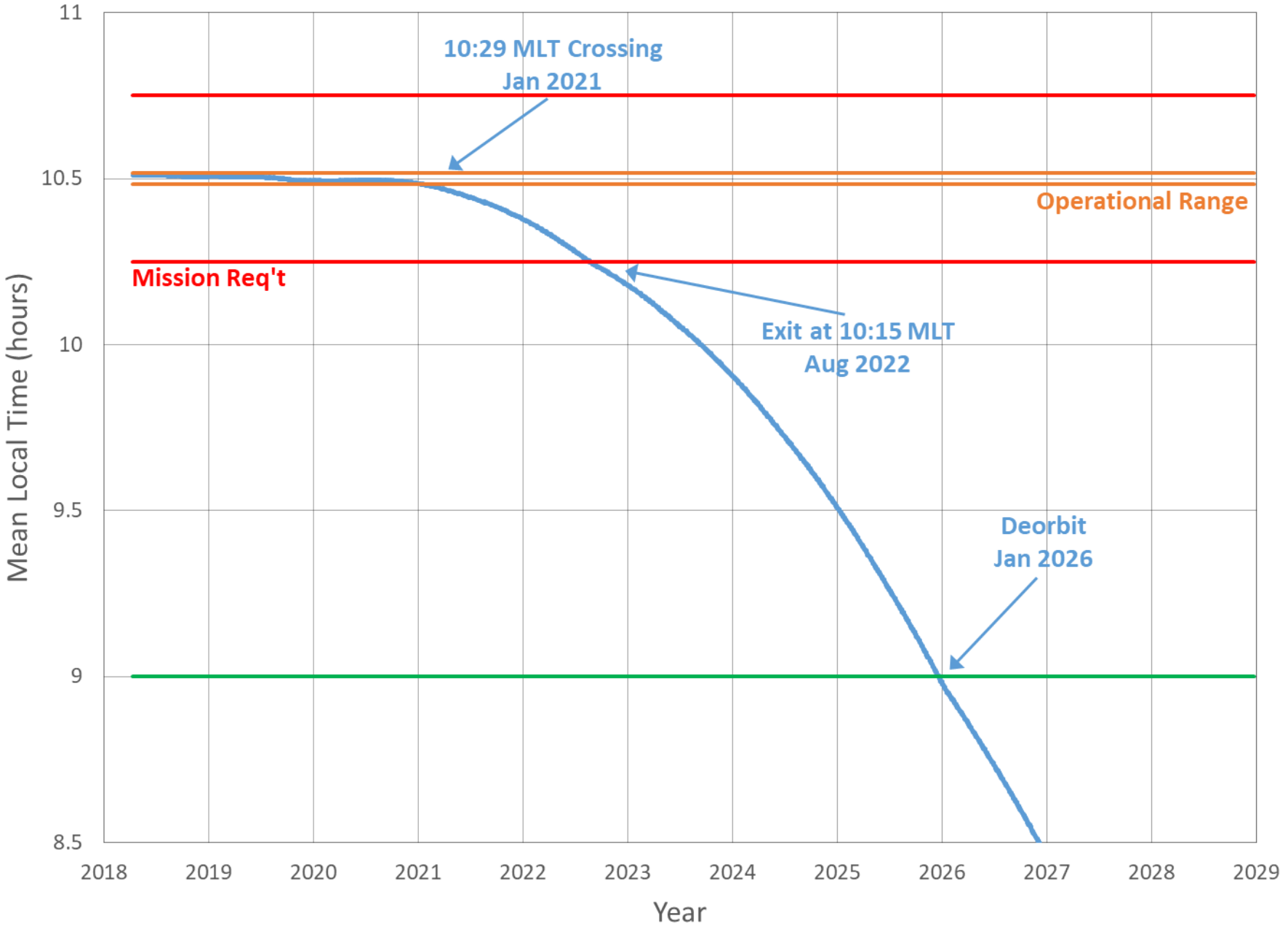
3) Changes to Terra and Aqua MLT.

   - Ideally, this would be a good time to transition CDR from Aqua to NOAA-20 and use S-NPP to develop new VIIRS-based ADMs.

4) CERES production code improvements.

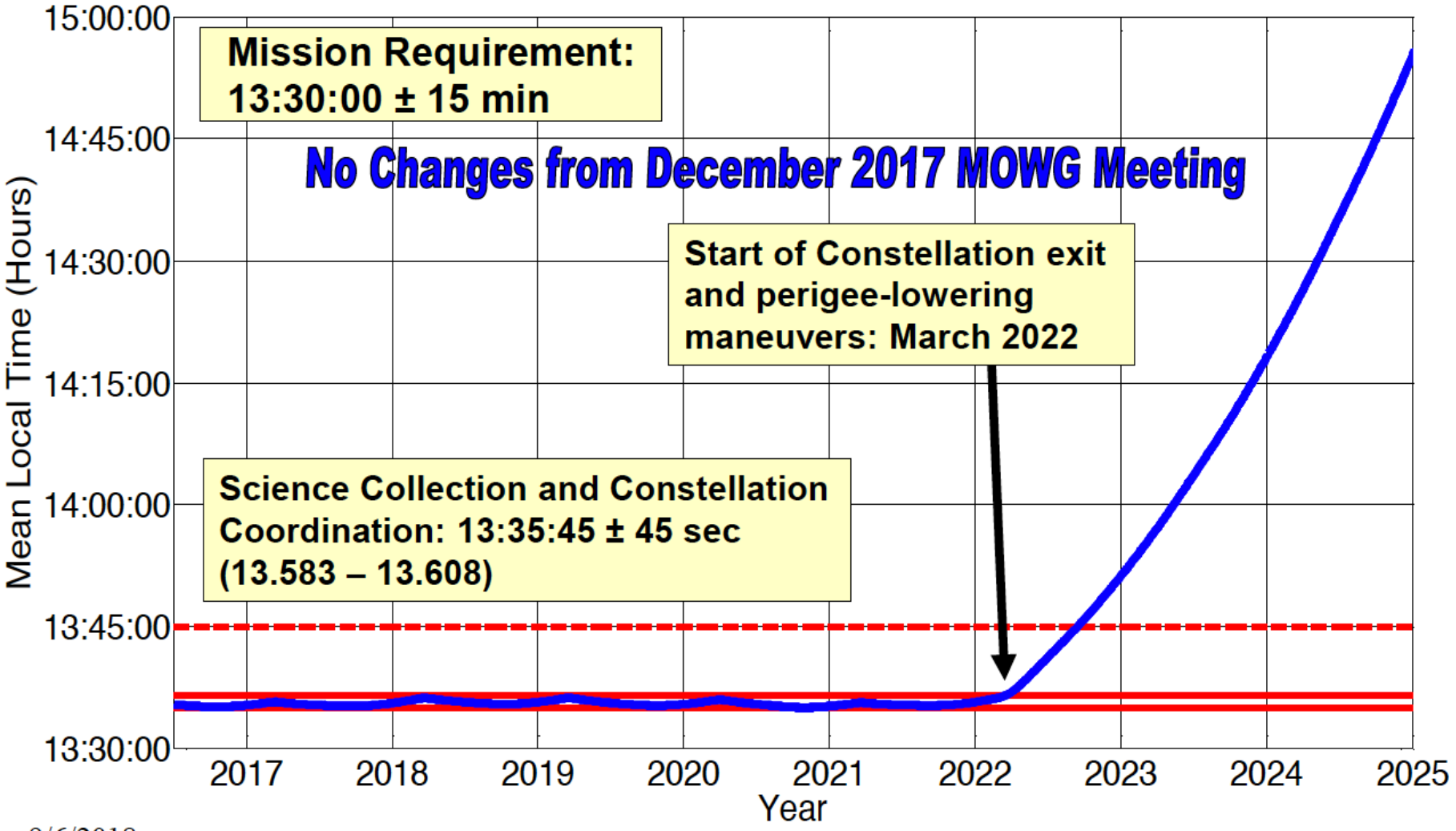
5) CERES algorithm improvements (particularly those enabling a seamless transition across satellite platforms).

# Terra Predicted Mean Local Time



Presented at ESC/A-Train MOWG Meeting on 12/6/2017

# Aqua Predicted MLT with A-Train exit in March 2022



# S-NPP Edition1 Product Availability

| Product | Platform | Processed through | Current | Publically Available |
|---|---|---|---|---|
| BDS | S-NPP | 04/2018 | Yes | Yes |
| SSF | S-NPP | 04/2018 | Yes | Yes |
| SSF1deg-Hour | S-NPP | 03/2018 | Yes | Yes |
| SSF1deg-Day/Month | S-NPP | 03/2018 | Yes | Yes |
| SYN1deg | Terra+S-NPP | 10/2017 | Yes | Yes |

# S-NPP Plans

**Edition 1:**

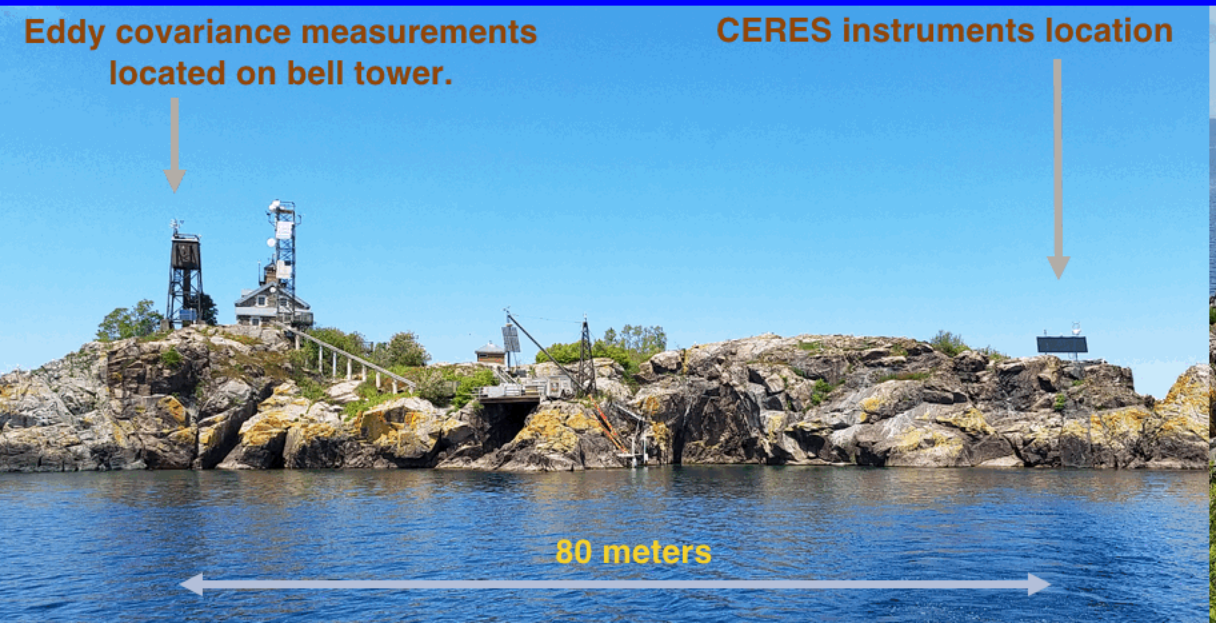
- Instrument gains (from onboard calibration) were taken into account. No attempt was made to place FM5 on same radiometric scale as FM3 or correct for spectral response function changes with time.
- ED1 cloud retrieval, ADMs, TISA & SARB algorithms were based upon those from Aqua.
  - Some changes to VIIRS cloud mask since water vapor and $CO_2$ bands are unavailable.
  - Cloud retrieval look-up tables were recomputed for VIIRS bands.

**Edition 2:**

- Will place FM5 on same radiometric scale as FM3.
- Will correct for FM5 spectral response function changes with time (LW daytime only).
- Will place VIIRS on same radiometric scale as MODIS Aqua, use the latest version of VIIRS level 1b, tune VIIRS cloud mask to be consistent with MODIS-Aqua.
- Will not ingest CrIS WV & $CO_2$ radiances to supplement VIIRS.
- Will place SNPP in RAP mode in early 2019 to enable ADMs to be constructed.

# Granite Island

- New location surface validation site.
- 2.5 acre island located about 5 miles offshore in Lake Superior.
- The island already hosts eddy covariance measurements for the Great Lakes Evaporation Network (GLEN).
- Shortwave, longwave, and AERONET instruments installed on the island in June 2018.
- Site accepted by BSRN in July, 2018.
- Actively working a seagull problem.
- Data is flowing.


# Upcoming Conferences & Meetings of Interest

**CLIVAR/GEWEX Earth's Energy Imbalance Workshop**
- November 13-16, 2018, Toulouse, France.

**American Geophysical Union Fall Meeting**
- December 10-14, 2018, Washington, DC.

**American Meteorological Society Annual Meeting**
- January 6-10, 2019, Phoenix, AZ.

**European Geophysical Union**
- April 7-12, 2019, Vienna, Austria.

**Spring 2019 CERES Science Team Meeting**
- May 7-9, 2019, NASA LaRC, Hampton, VA.

**IUGG General Assembly**
- July 8-18, 2019, Montreal, Quebec, Canada.

**Gordon Research Conference: Radiation & Climate**
- July 21-26, 2019, Bates College, Lewiston, ME, US.

End